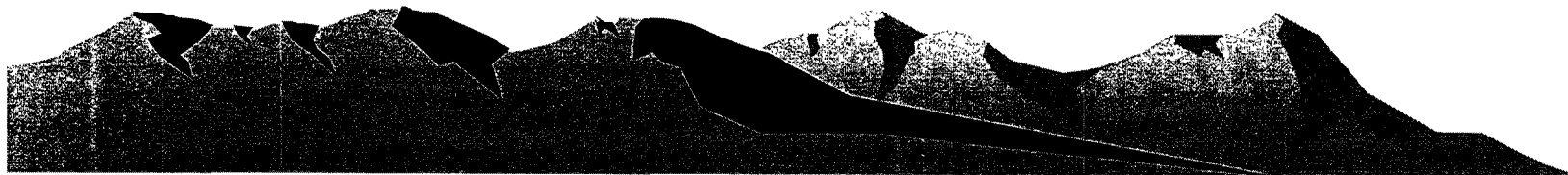


Onsite Reservoir Makeup to Circulating Water

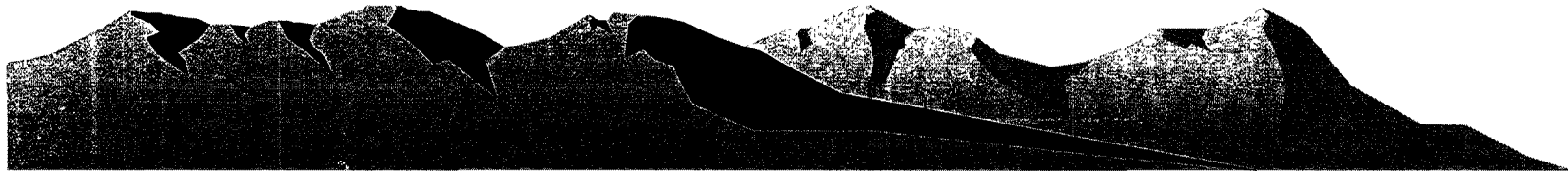
Tested

March 7 – 28, 2005



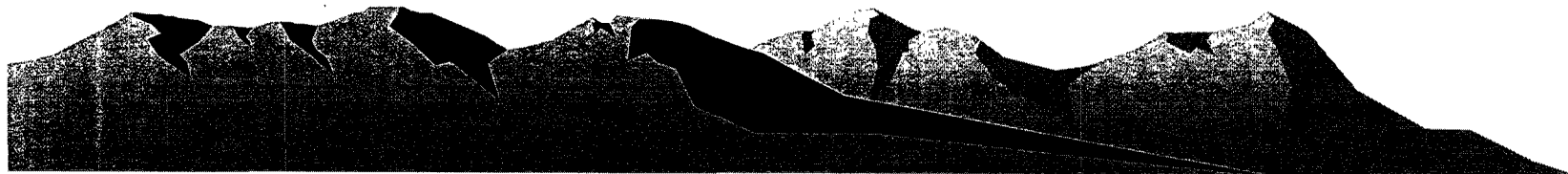
Purpose of Test

Verify excellent operation of
Circulating Water System
without SCU's



Phases of Testing

1. Bench test with SCU Water (4/03)
2. Bench test with Onsite Water (10/03)
3. On-Site Lab with Onsite Reservoir Water (6-8/04)
4. Unit #2 Circulating Water Test (3/05)



Testing – Phase 1

Bench Test with SCU Water

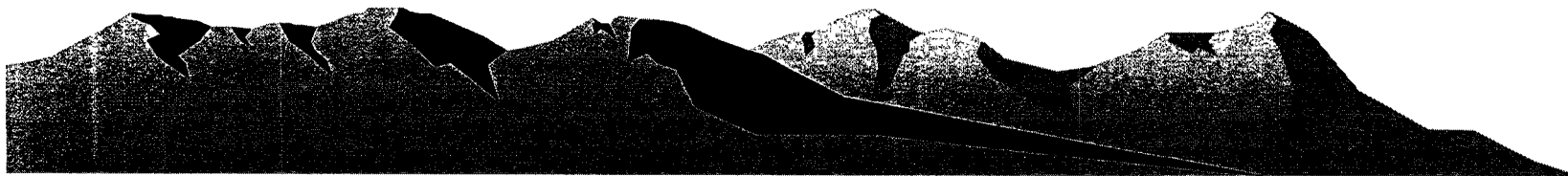
- April 2003
- GE R & D Lab - Trevose, Pennsylvania
- Synthesized water
- Initial deposit noted at 8.5 pH



Testing –Phase 2

Bench Testing w/Onsite Water

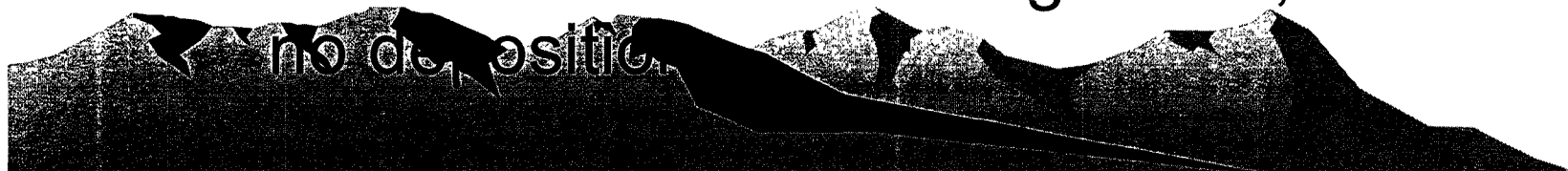
- 1600 ppm Ca, 2600 ppm Mg, 210 ppm SiO₂
- Tested at pH levels of 7.2, 7.6, 8.0 and 8.2
- Minor deposition was noted at 8.2 pH
- Soluble iron can catalyze deposition
 - Only significant during transition between programs



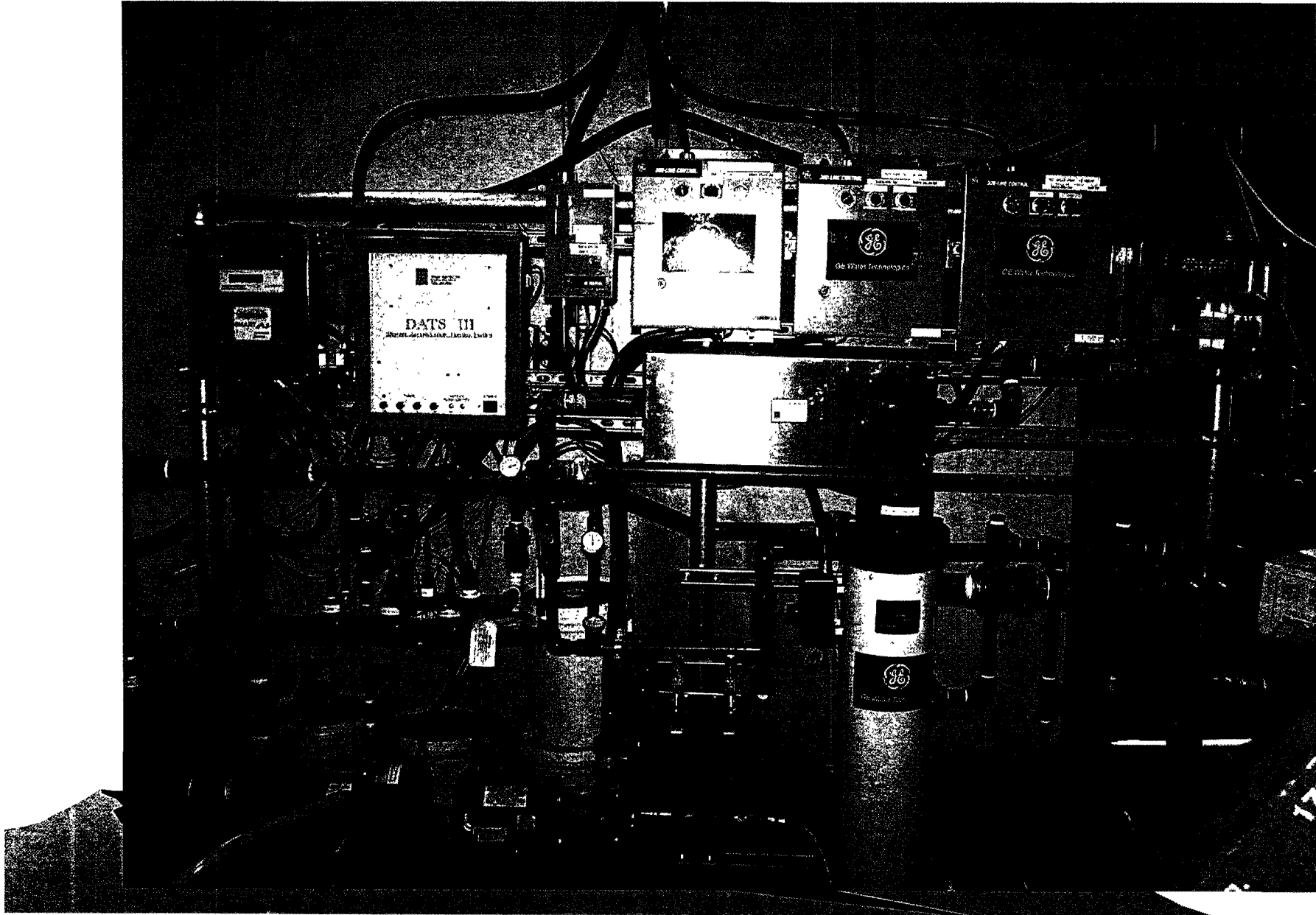
Testing -Phase 3

On-Site Lab Study

- Conducted at IPSC w/Pilot Cooling Tower
- Purpose - Validate R & D studies
- Used Onsite Reservoir Water Makeup
- Operated successfully at target limits w/ no deposition
- At target pH, $\text{Mg} \times \text{SiO}_2$ went to 972,000 for ~2-days with no change in HTR
 - Target limit = 500,000
 - At almost double the target limit, HTR indicated



On-Site Lab

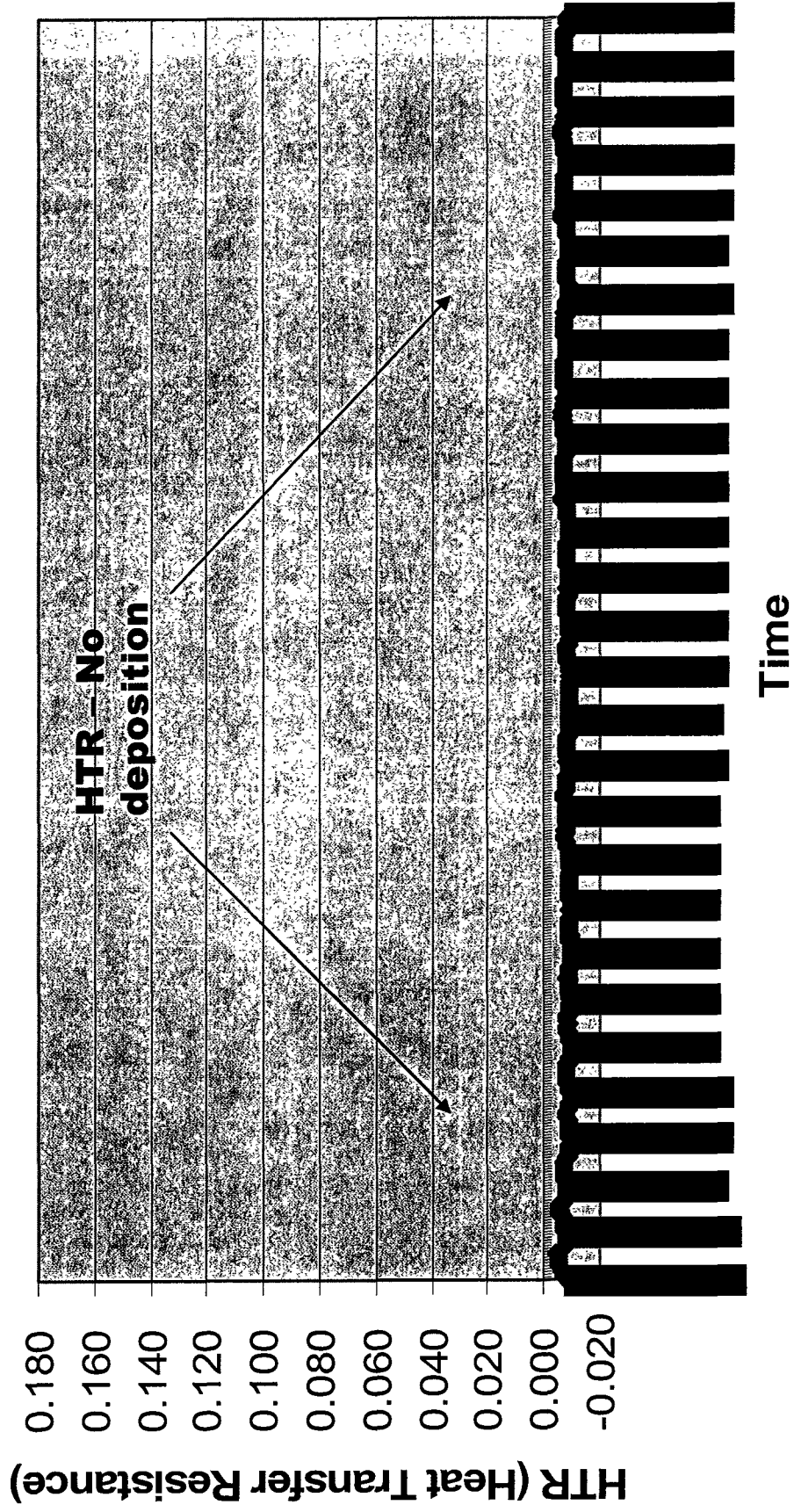


IP12_000389

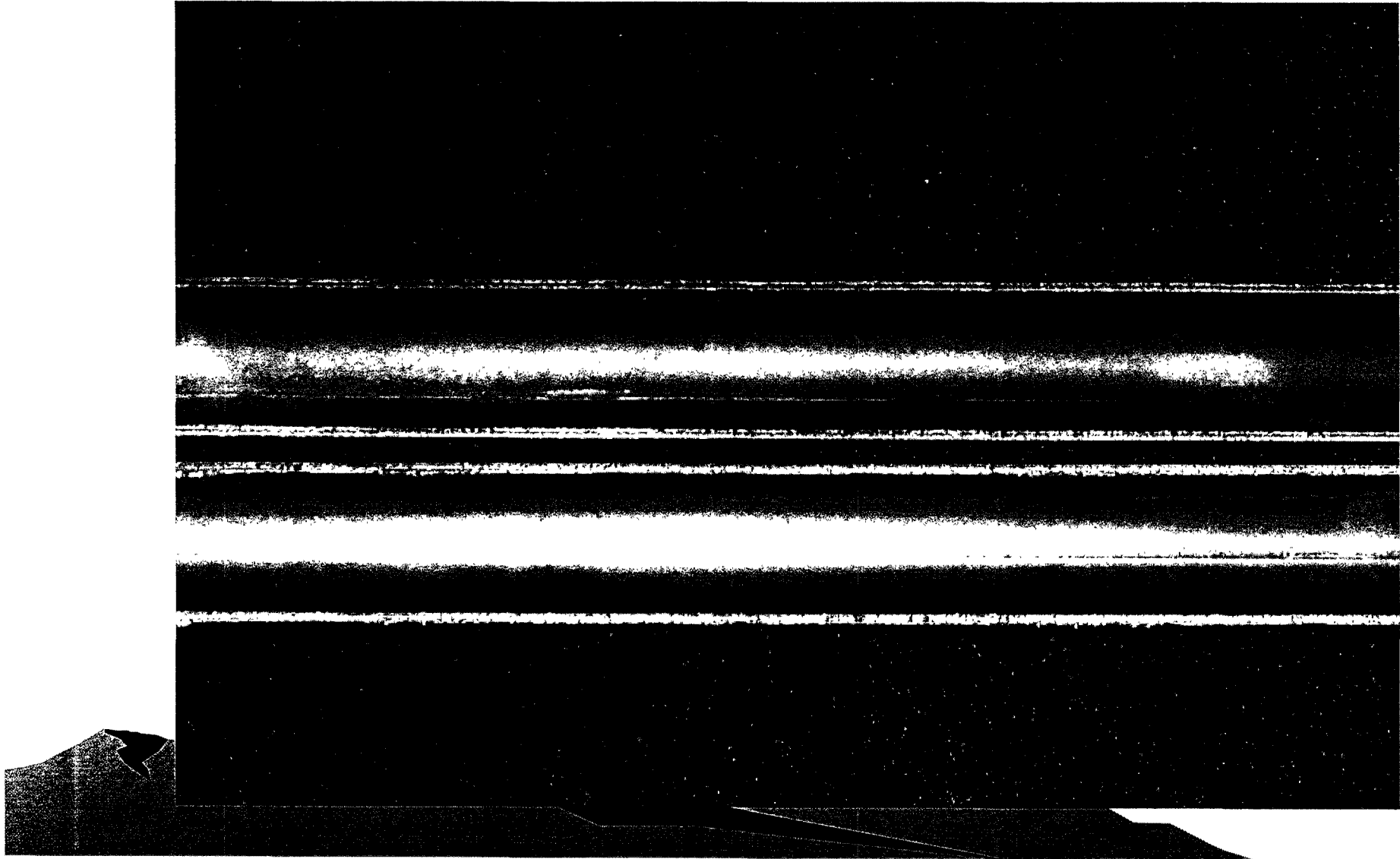
Testing -Phase 3

On-Site Lab Study

IPSC - 4th Onsite Study



Testing -Phase 3 On-Site Lab Study

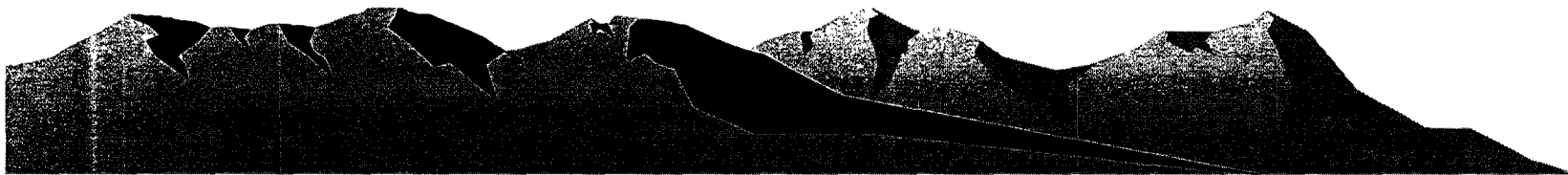


IP12_000391

Testing - Phase 4

#2 Circ Water Test Plan

- Operation
- Monitoring and Lab testing



Testing - Phase 4

#2 Circ Water Test Plan

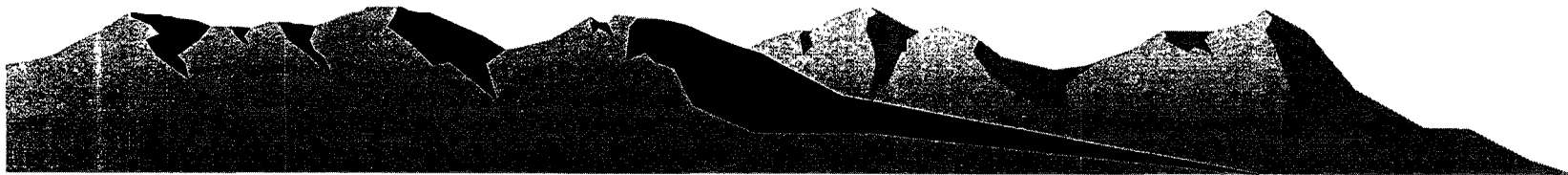
PAI Target Limits:

- | | |
|-------------------------------------|-------------------|
| • pH (at 25 C) | 7.2 |
| • Silica, ppm | Less than 200 |
| • Calcium, ppm as CaCO ₃ | Less than 2000 |
| • Magnesium x Silica Product* | Less than 500,000 |
| • Reactive Iron, ppm | Less than 1 |
| • Scale Inhibitor, ppm | Based upon cycles |
| • Corrosion Inhibitor, ppm | 3 - 5 ppm |



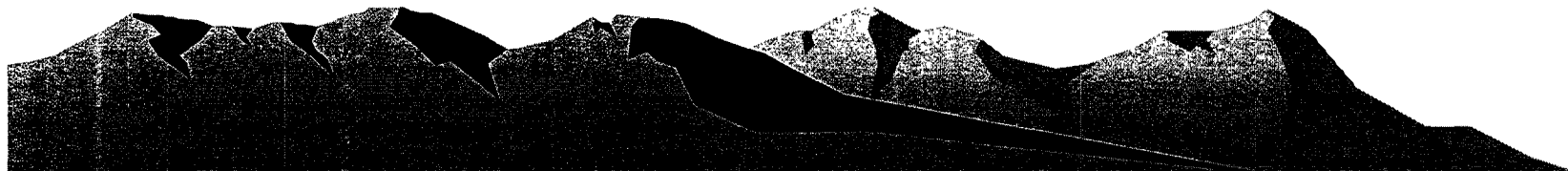
Phase 4 - #2 Circ Water Test Operation Changes

- Fed Onsite Reservoir Water (rather than SCU water) as Circulating Water Makeup
- Reduced system pH from ~7.4 to ~7.2 pH
- Increased dispersant (BL 5306) based on Silica
- Added corrosion inhibitor (MS 6222)



Phase 4 - #2 Circ Water Test Lab Testing and Monitoring

- Lab
 - Continued current testing regime
 - Added testing for iron
 - Monitored pH
- On-line testing
 - DATS III (Deposit Accumulation Testing System)
 - Heat transfer resistance (**HTR**), conductivity, pH
- GE Betz sampling
 - TAP analyses
 - Corrosion coupons (test period and normal 90-day)



Phase 4

Test Results - #2 Circ Water

Chemicals and Maintenance

DATS data

Blowdown rates

Limiting factors

Corrosion rates



Chemicals and Maintenance

	Cost/Unit	With SCU's		Without SCU's	
		Quantity/Yr	\$/Year	Quantity/Yr	\$/Year
SCU Polymer (lbs)	\$ 1.68	6,925	\$ 11,634	0	\$ -
Ferric Sulfate (tons)	\$ 125.00	1,294	\$ 161,750	0	\$ -
Lime (Tons)	\$ 62.93	6,800	\$ 427,924	2	\$ 126
Sulfuric Acid (Tons)	\$ 50.00	1,600	\$ 80,000	5,500	\$ 275,000
Silica Dispersant (lbs)	\$ 1.59	62,000	\$ 98,580	95,000	\$ 151,050
Corrosion Inhibitor	\$ 1.00	0	\$ -	39,000	\$ 39,000
SCU Eqpt. Maintenance	\$ 77,000.00	1	\$ 77,000	0	\$ -
SCU Power	\$ 20,592.00	1	\$ 20,592	0	\$ -
Acid Feed Maintenance	\$ 5,000.00	1	\$ 5,000	2	\$ 10,000

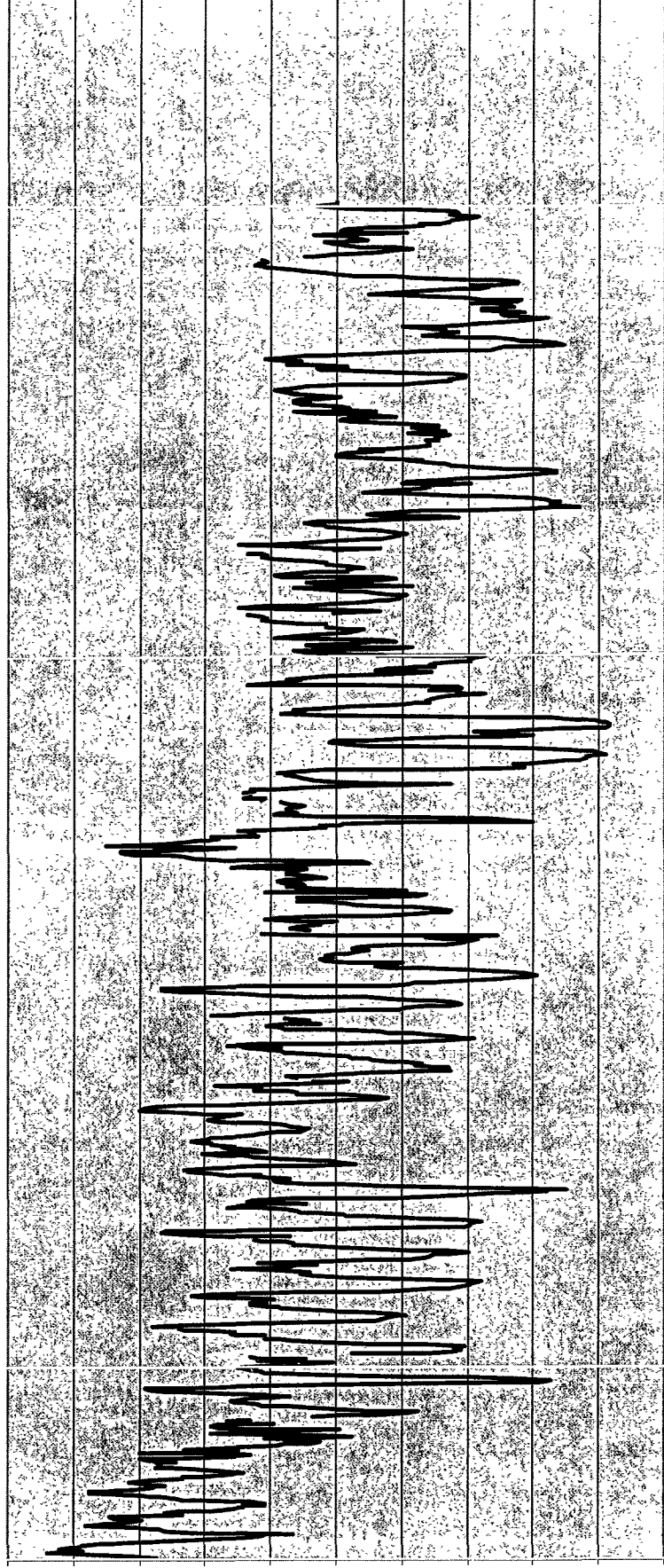
Total \$ 882,480 \$ 475,176

Difference \$ 407,304

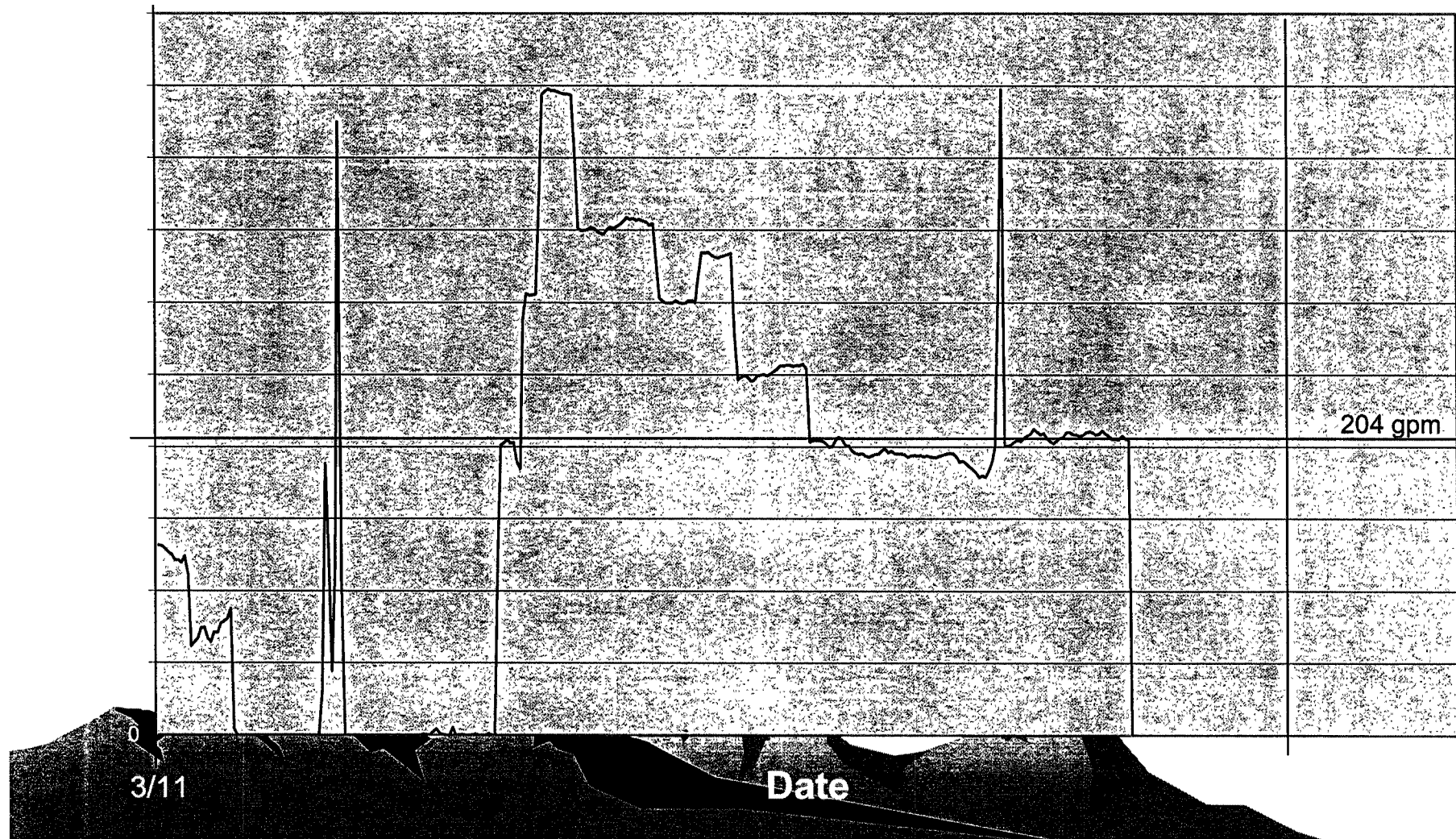
1. Acid at \$50/ton, Ferric at \$125.00/ton

2. Acid and Inhibitor usage have been updated based on test information to-date.

DATS III Data – Heat Transfer Resistance



Blowdown Rates



IP12_000399

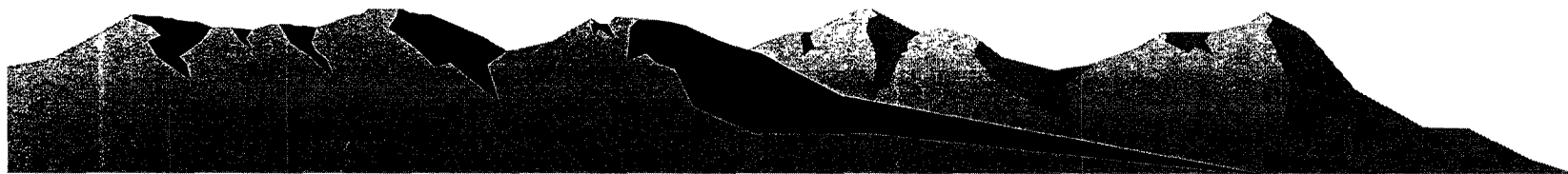
Limiting Factors

Calcium Carbonate

Magnesium Silicate

Silica

Soluble Iron



Limiting factors

How close to scaling?

- Calcium Carbonate

- Ran to the limit in test
 - LSI looks good even above that level

- Magnesium Silicate

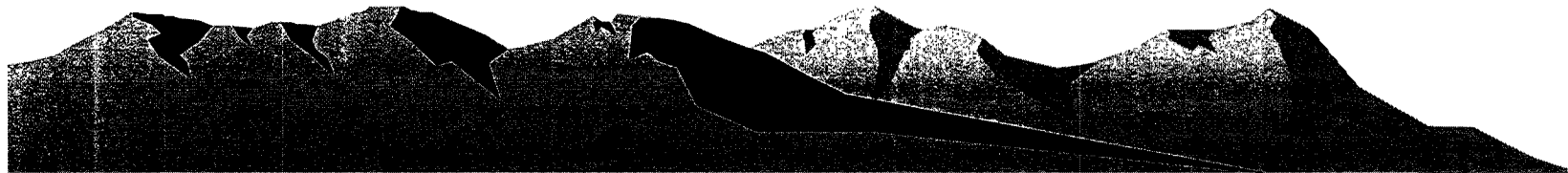
- Ran almost double the limit in Phase 3
 - HTR didn't move even at that level

- Silica

- Ran to 220 ppm (limit 200) in Phase 3 – no problems

- Soluble Iron

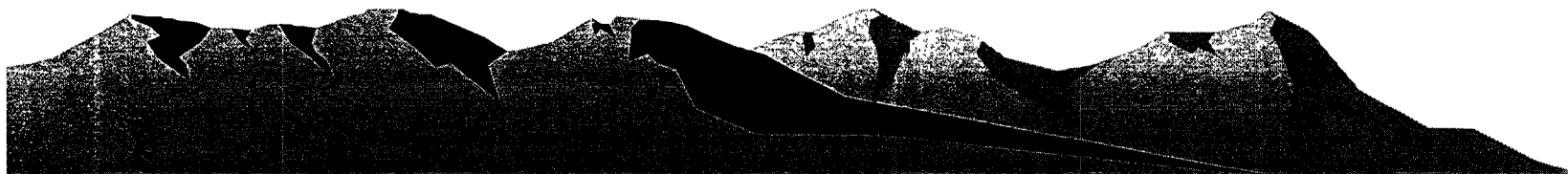
- Only a concern during transition



Corrosion rates

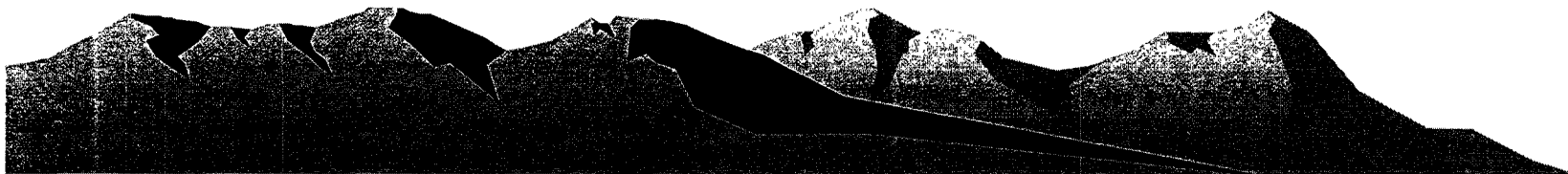
21 day exposure

- Admiralty 4.7 mpy
- Titanium <0.1 mpy
- Cast Iron 11.9 mpy



“Slow moving” system

- Over 5 million gallons in system
- Change occurs slowly!



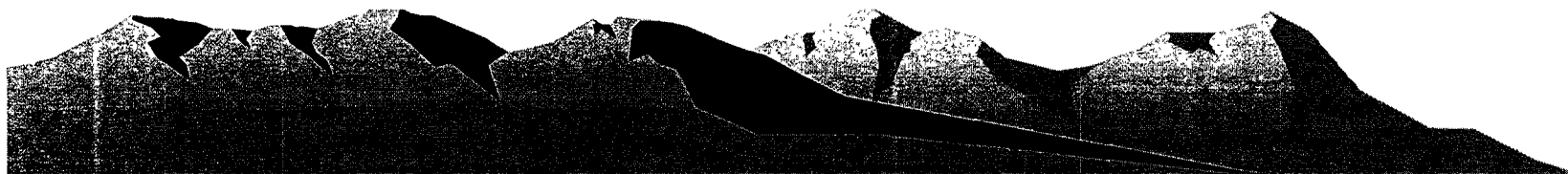
Recommendations

- Install additional acid pumps
- Switch to Onsite Reservoir makeup



Additional Discussion

- Off-site acid storage
- Minimize well water in system, at least at first
- Operate a third DMAD pump during summer



Thank you for your participation!

